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A Report on a Nonfatal Shark Attack in the Hawaiian Islands[1]

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FEWER THAN 100 shark attacks occur each year worldwide, and less than half of these result in fatalities (Baldridge 1973). Reports on roughly 20 percent of these attacks provide sufficient information to permit identification of the species involved. Shark attacks in Hawaii are relatively rare events. Prior to 1973, a total of 31 attacks had been recorded from Hawaiian coastal waters (Baldridge 1973). This report presents information pertaining to a nonfatal attack in which the species of the attacking shark was determined and its size and weight estimated from evidence gathered following the incident. Details of the attack may be summarized as follows:

DATE: 4 August 1980

TIME: 1800 hr (approximately)

LOCATION: Coastal waters approximately 1.5 mi south of the center of Lahaina, Maui

WEATHER CONDITIONS: Overcast with showers

UNDERWATER VISIBILITY: Less than 1 m

IDENTITY of VICTIM: Caucasian male, 18 yr, 6 ft 1 in. tall, 170 lb (estimate)

ACTIVITY AT TIME OF ATTACK: Resting on "boogie board" just outside the surf line (depth 3–6 m)

REPORT OF VICTIM

Victim stated that he received no warning of the attack before hearing a splash and receiving a strong shove from his left side. As he rolled off the board to his right, he saw the broad head and dorsal fin of the attacking shark. The victim and his board were pushed through the water briefly before the animal broke off the attack. The young man returned to shore without assistance and was taken to the Kaiser Permanente Clinic in Lahaina for treatment.

DESCRIPTION OF WOUNDS RECEIVED

The victim had four separate, horizontal, and parallel lacerations 2.5–5.0 cm apart. The lacerations were located on his left flank from the level of T_{12} to 3 cm below the iliac crest. The most cranial and posterior of these was a 2-cm linear laceration through the dermis to the subcutaneous tissues. The next two more caudal and anterior injuries were skin flaps 4 cm (length) by 1.5 cm (width). These were ventrally based in the deep dermis. The fourth laceration, over the iliac crest, was 8 cm long, 4 cm wide, and 2–3 cm deep into the subcutaneous fat. The flap of skin remaining possessed a 1-cm pedicel and was reattached. A total of 52 stitches were required; no vital organs were damaged and bleeding was minimal.

IDENTIFICATION OF THE ATTACKING SHARK

Little information was provided by an examination of the wounds, save the possible 2.5-cm spacing between the teeth. The boogie board was retrieved and examined in detail. A serrated crescent 36 cm wide had been bitten from the board, and the missing section was later recovered. The dental impressions made in the firm styrofoam were extremely clear (Figures 1, 2). In section,

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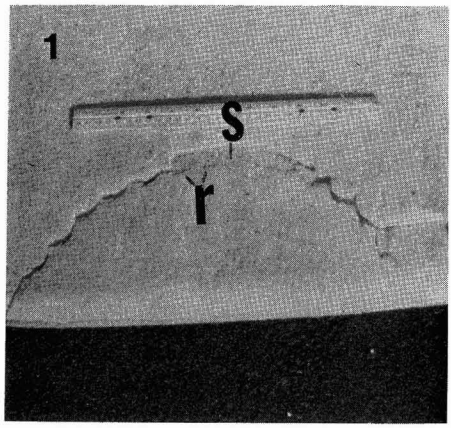

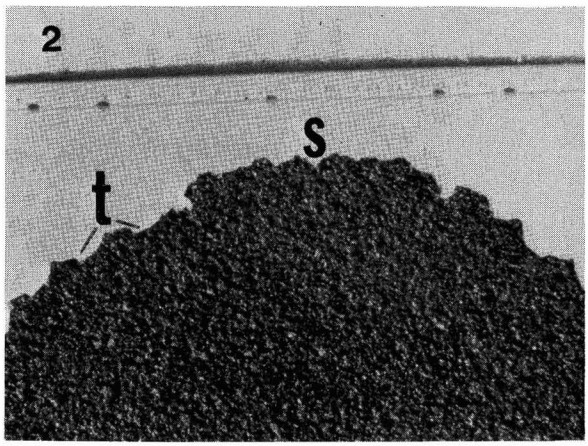

FIGURE 1. Left rear portion of boogie board, showing crescent-shaped bite impression left by the upper jaw; note symphysis location (s) and impressions left by replacement teeth on either side of the midline (r).

FIGURE 2. A portion of the bite crescent, with the small section removed; note the characteristic tooth marks (t) and symphysis (s).

tooth impressions on either side of the palatoquadrate symphysis measured 3 cm in width and 2.5 cm in height. The impressions were assymetrical and curved to the respective corners of the mouth. The smooth-coated lower surface of the board recorded increasingly fine serrations on each tooth near the tip, which was located 2.4 cm from the left edge of a right lower tooth having a basal width of 3 cm. Serration size graded from almost 3 mm to finer than 1 mm. These data were felt to be sufficient to identify the attacking animal as a tiger shark, *Galeocerdo cuvier*. Out of 257 attacks in the shark attack file in which species identification was possible, 25 were attributed to tiger sharks, making this species the second most frequently involved in attacks on humans (Baldridge 1973).

ESTIMATION OF SIZE AND WEIGHT OF ATTACKING ANIMAL

From the location of the symphyseal teeth it was evident that the shark had struck the board and its rider slightly from the front. Tiger sharks possess a typical dental formula of between $\frac{9-9}{9-9}$ and $\frac{11-1-12}{12-1-12}$ (Bigelow and Schroeder 1948). The impression left in the dorsal surface of the board yielded a partial formula of $\frac{8-6}{\quad}$. The lower surface of the board retained an impression of $\frac{\quad}{10-1-x}$ for the lower jaw; because of the large skeg and the offset angle of approach, it was not possible to determine a right lower count. The curvature of the upper jaw was traced and duplicated, and the jaw width was measured at the level of $\frac{9-9}{\quad}$. The jaw width so determined was 447 mm (17.6 in.). A preliminary estimation of the total size of the shark was made using the jaw width: total length ratio of 0.084:1.0 reported for an immature specimen by Bigelow and Schroeder (1948). This yielded an estimate of 5.3 m, which is close to the maximum size reported for the species. Because the ratio of 8.4 percent had been derived from a very small tiger shark (only 1.245 m total length), it was felt advisable to verify this estimate.

Data on jaw width for 11 tiger sharks ranging from 2.221 to 3.738 m in total length were obtained from the records of the Mote Marine Laboratory (Sarasota, Fla.). The data indicated a mean relationship between jaw width and total body length of 0.104:1.0

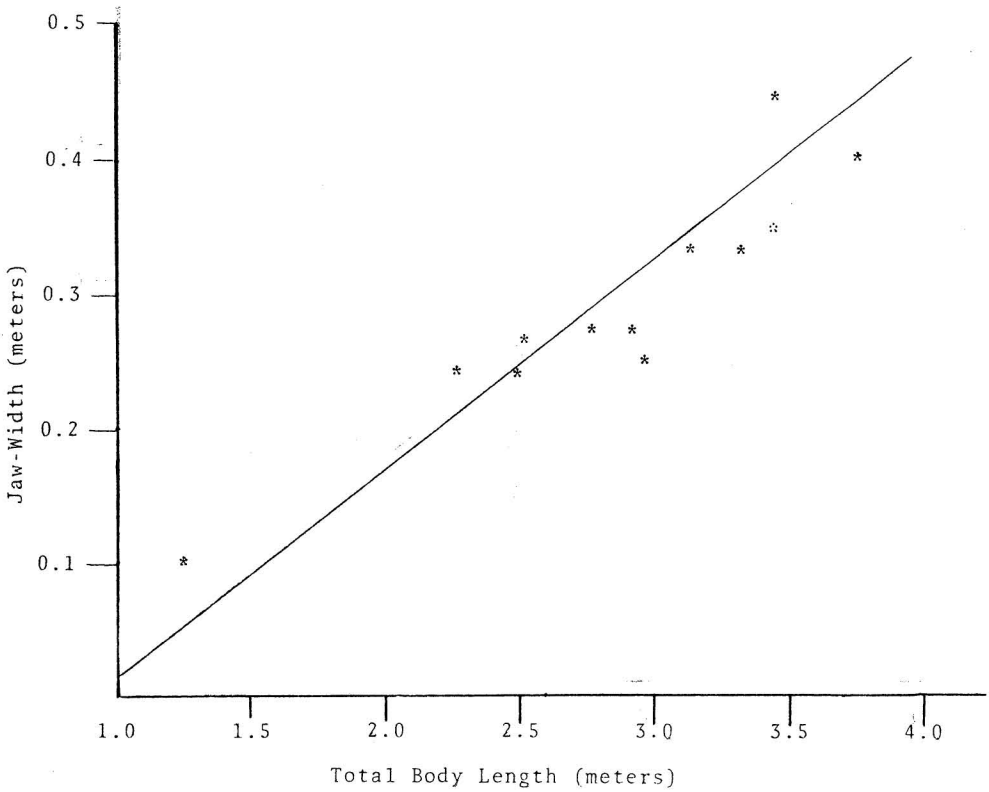

FIGURE 3. Scatter diagram and regression line for determination of total body length based upon known jaw width for the tiger shark, *Galeocerdo cuvier*.

(10.4 percent), higher than the value for the single immature specimen. This relationship produced a size estimate of 4.3 m (14.1 ft) for the attacking animal. Regression analysis of the jaw width: total body length relationship permitted the most accurate estimation of size. The scatter diagram and calculated regression line for estimating total length from jaw width is presented as Figure 3. This regression is linear, and the two parameters are highly correlated. The equation for deriving total body length from jaw width may be summarized as:

$$TL_{meters} = 2.83 + 6.54(JW_{meters} - 0.300).$$

In the case under consideration, this yields an estimate of 3.79 m (12.5 ft). The standard error of the estimate is 0.279 m; the 95 percent confidence limits are ± 0.7 m. Bigelow and Schroeder (1948) indicate that animals between 3.65 and 3.95 m weigh between 386 and 634 kg (850–1395 lb).

COMPARISON WITH OTHER RECORDED ATTACKS

Almost three-fourths of recorded attacks may represent territorial defense rather than concerted feeding behavior (Baldridge 1973). Lacerations without significant tissue loss, produced by a slashing movement of the upper jaw, are frequently observed, and the mortality rate is low, averaging 35 percent. The attack reported above cannot be considered typical in that the lacerations resulted from a biting action of both the upper and lower jaws. Had the board not prevented a more secure seizing of the victim, the attack would almost certainly have resulted in a fatality.

POTENTIALLY SIGNIFICANT FACTORS IN THE ATTACK

The incident occurred late in the day, under twilight lighting conditions. Springer (1963) reports that tiger sharks feed most actively at this time, frequently taking objects from the surface of the water. Underwater visibility in the area was low, and other sharks were present in the area (reported and ignored by local surfers). Both these factors are felt to encourage aggressive behavior in sharks. Finally, the victim's bathing trunks (shredded in the attack), the skegs of the boogie board, and the entire dorsal surface of the board were international orange, a color known to be highly attractive to sharks, presumably because of its high reflectivity.

ACKNOWLEDGMENT

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